Biological Assessment Report

Williams Creek
Lawrence County, Missouri

Fall 2015 – Spring 2016

Prepared for:
Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MoDNR**) Water Protection Program (**WPP**), the Environmental Services Program (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate biological assessment and habitat study of Williams Creek (water body identification number 3172) during the fall of 2015 and spring of 2016. Fall sampling was conducted on September 22-23, 2015 and consisted of macroinvertebrate sampling, stream habitat assessments, and water quality sampling at three stations on Williams Creek. During the spring, sampling was conducted on March 16, 2016 and consisted of macroinvertebrate sampling and water quality sampling at the same study stations. Sampling was conducted by Brandy Bergthold, Brian Nodine, and Carl Wakefield. A bioassessment also was conducted on Williams Creek in the spring and fall of 1997. Macroinvertebrate summary data are presented for comparison in this report.

Williams Creek is classified as a class P stream in the Missouri Water Quality Standards (**WQS**, MoDNR 2014) with the following designated uses: irrigation; livestock and wildlife protection; protection of warm water aquatic life and human health-fish consumption; category A whole body contact recreation; and secondary contact recreation. A class P stream is defined as a stream that maintains permanent flow even in drought periods. Category A whole body contact applies to waters that are established as public swimming areas and public recreational use areas. The study reach of Williams Creek is classified as a gaining stream (a stream with flow influence from a subsurface source). Although a small section of Williams Creek is classified as a cold-water fishery, this section is located downstream of the sampling stations. Williams Creek is listed on the Department's 303(d) List of Impaired Waters for *Escherichia coli* from rural nonpoint sources.

2.0 Study Area and Sampling Locations

Williams Creek is a tributary of the Spring River and is located in the Ozark/Neosho Ecological Drainage Unit (**EDU**) in central Lawrence County (Figure 1). An EDU is a region in which biological communities and habitat conditions can be expected to be similar.

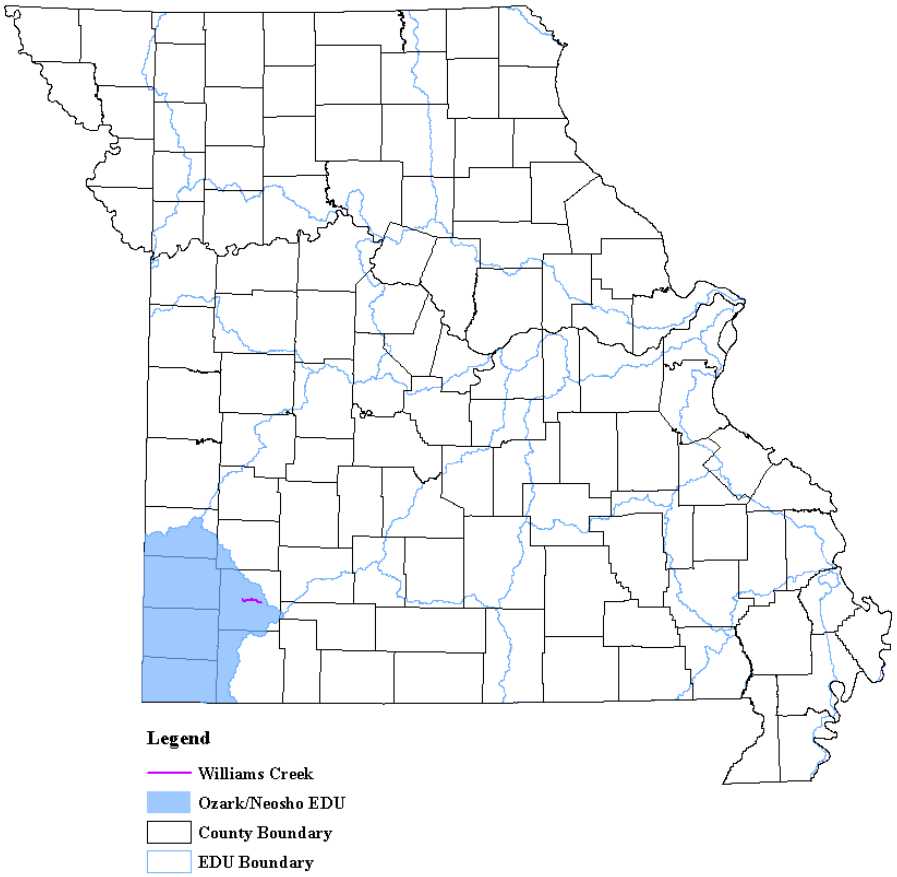


Figure 1. Location of Williams Creek within the Ozark/Neosho EDU

The study stations bracketed the Mount Vernon Waste Water Treatment Facility (**WWTF**, Permit Number MO-0022381); one station was located upstream of the discharge point, and two stations were located downstream of the discharge point. Station locations and descriptions are listed below and shown in Figure 2.

Sampling Locations

All Williams Creek stations were located in Universal Transverse Mercator (**UTM**) Zone 15.

Williams Creek Station 0.5 (SW1/4 SW1/4 sec. 27, T. 28 N., R. 27 W.) is located approximately 0.7 miles downstream of the Highway V bridge at property used for a private airplane runway. This station is approximately 3.0 miles downstream of the WWTF. Coordinates collected at the upstream boundary of the sample reach are UTMN 4106755, UTME 422424.

Williams Creek Station 1 (SE1/4 SW1/4 sec. 26, T. 28 N., R. 27 W.) is located downstream of County Road 1117 and approximately 1.3 miles downstream of the

WWTF. Coordinates taken at the upstream terminus of the sample reach are UTMN 4106780, UTME 424477.

Williams Creek Station 3 (NE1/4 SW1/4 sec. 30, T. 38 N., R. 26 W.) is located at Spirit of 76 Park in Mount Vernon, upstream of the spillway to Williams Creek Lake. Coordinates of the downstream terminus are UTMN 4107296, UTME 427334.

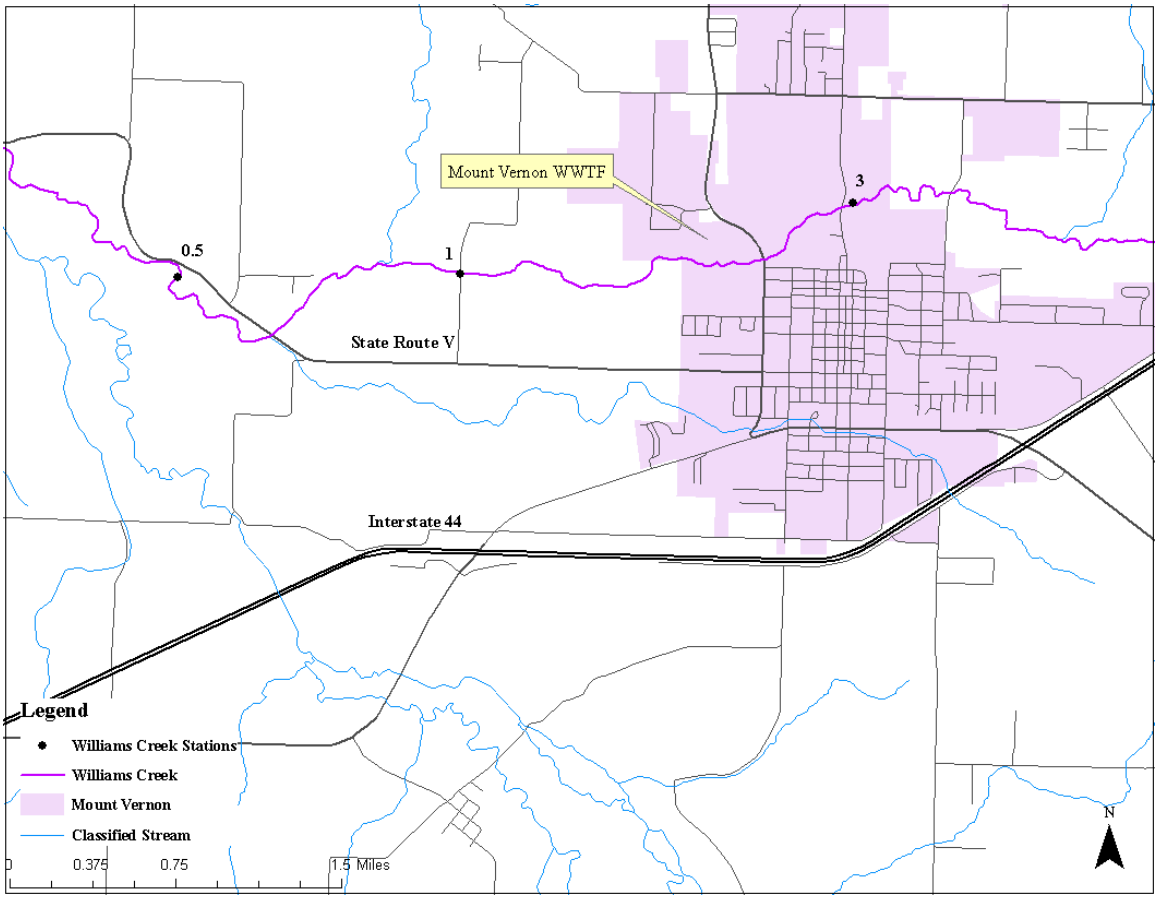


Figure 2. Williams Creek Sampling Locations

3.0 Objectives

The objective of this study was to determine if Williams Creek supports its protection of warm water aquatic life beneficial use designation following upgrades to the Mount Vernon WWTF. The macroinvertebrate community and instream habitat were compared longitudinally among the three Williams Creek stations; comparisons were also made with biological criteria reference (**BIOREF**) stream data from the Ozark/Neosho EDU. Water quality and nutrient parameters were compared longitudinally among the Williams Creek study sites. These parameters also were compared with Missouri's Water Quality Standards and the United States Environmental Protection Agency's (**USEPA**) Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion IX (USEPA 2000).

3.1 Null Hypotheses

1) Land cover characteristics in the Williams Creek watershed will be similar to the land cover characteristics of the Ozark/Neosho EDU.

2) Stream habitat assessment scores of Williams Creek will be similar to the stream habitat scores of Mikes Creek, a BIOREF stream in the Ozark/Neosho EDU.

3) The macroinvertebrate community in Williams Creek will be similar among longitudinally separate reaches of Williams Creek.

4) The macroinvertebrate community in Williams Creek will be similar to the macroinvertebrate community of BIOREF streams in the Ozark/Neosho EDU.

5) Physicochemical water quality in Williams Creek will meet Missouri WQS (MoDNR 2014).

6) Physicochemical water quality parameters in Williams Creek will meet USEPA recommendations.

4.0 Methods

4.1 Land Use Description

Table 1 compares the land cover percentages from the Ozark/Neosho EDU and the 12-digit Hydrologic Unit Code (**HUC**) containing the sampling reaches of the study stations. Percent land use data were derived from Thematic Mapper satellite images from 2000-2004 and interpreted by the Missouri Resource Assessment Partnership (Sowa et al. 2004). Figure 3 depicts the land use characteristics of the Williams Creek watershed.

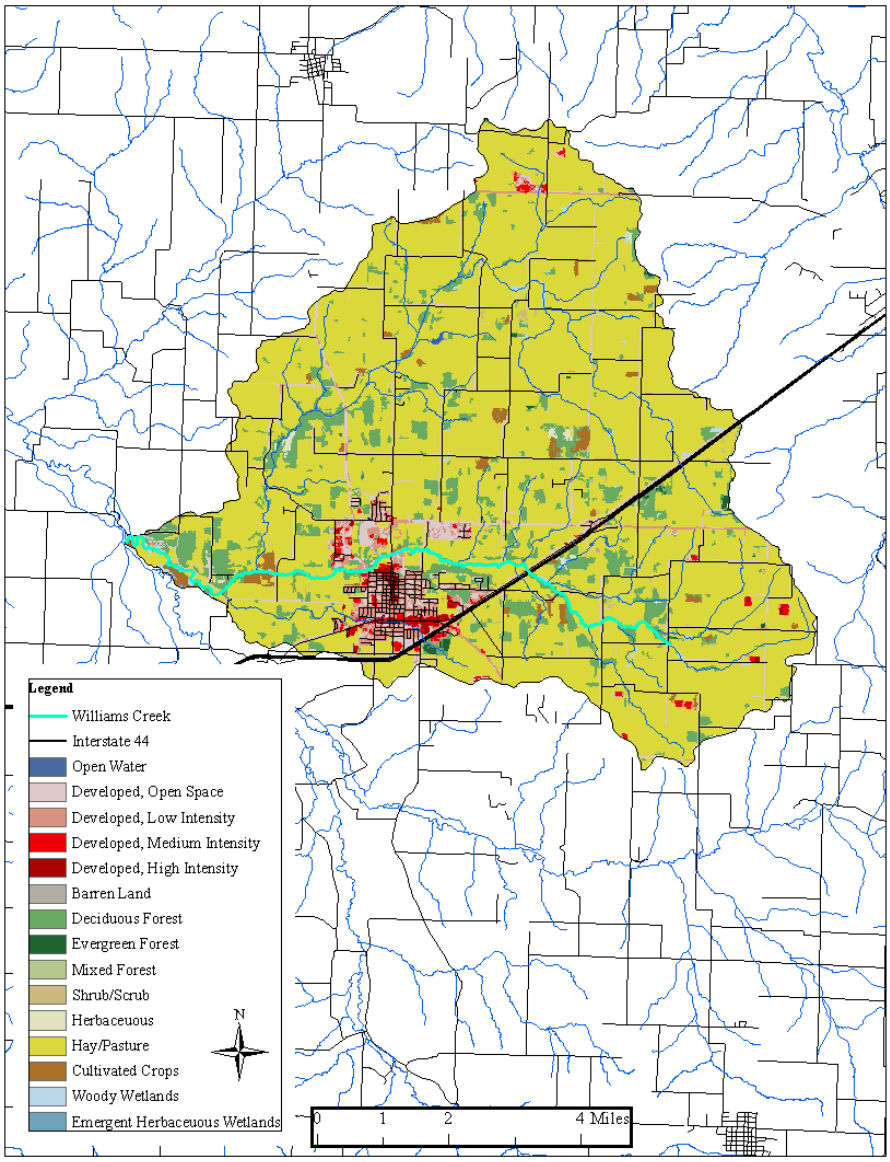


Figure 3. Land uses within the 12 digit HUC of Williams Creek

4.2 Stream Habitat Assessment Project Procedure

Standardized assessment procedures were followed as described for riffle/pool prevalent streams in the Stream Habitat Assessment Project Procedure (**SHAPP**, MoDNR 2016i). According to the SHAPP, an aquatic community is influenced by the quality of the stream habitat. Stream habitat quality is scored for each station and the scores are compared with a control stream (biological criteria reference reach) SHAPP score. If the SHAPP score at a test station is ≥75 percent of the SHAPP control score, the stream habitat at the test station is considered to be comparable to the control stream. Mikes Creek, located near Powell in eastern McDonald County, is a BIOREF stream chosen as the SHAPP control. The habitat assessment of Mikes Creek was conducted on September

24, 2015. SHAPP scores were calculated for the Williams Creek stations and compared to the SHAPP score of Mikes Creek.

4.3 Bioassessment

4.3.1 Macroinvertebrate Sampling and Analyses

Macroinvertebrate sampling was conducted according to the *Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure* (**SMSBPP**, MoDNR 2012). Williams Creek is considered a riffle/pool dominated system. The three standard habitats sampled at all locations were flowing water over coarse substrate, non-flowing water over depositional substrate, and submerged rootmat. Macroinvertebrate samples were subsampled in the laboratory and identified to taxonomic levels as specified in MoDNR's *Taxonomic Levels for Macrocinvertebrate Identifications* SOP (MoNDR 2016j) to develop biological metrics (MoDNR 2012).

Reference streams within the EDU represent the best available conditions and are the basis for calculating Macroinvertebrate Stream Condition Index (**MSCI**) scores. Williams Creek macroinvertebrate data were evaluated relative to BIOREF streams in the Ozark/Neosho EDU. Biological criteria are calculated separately for the fall (mid-September through mid-October) and spring (mid-March through mid-April) index periods. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric MSCI. The four components of the MSCI are Taxa Richness (**TR**); Ephemeroptera, Plecoptera, and Trichoptera Taxa (**EPTT**); Biotic Index (**BI**); and the Shannon Diversity Index (**SDI**). An MSCI score of 16-20 is considered fully supporting, 10-14 partially supporting, and 4-8 non-supporting of the protection of warm water aquatic life beneficial use designation as listed in the Missouri WQS (MoDNR 2014).

4.3.2 Physicochemical Water Sampling and Analyses

Results for physicochemical water parameters were examined by season and station by *in situ* field measurements and grab samples collected in accordance with the SOP MDNR-ESP-001, *Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations* (MoDNR 2016h). All samples were kept on ice during transport to ESP.

Water quality parameters were measured *in situ* or collected and returned for analyses at the ESP laboratory in Jefferson City. Turbidity (**NTU**, MoDNR 2016a) was measured in the ESP, WQMS biology laboratory. Discharge (cubic feet per second-**cfs**, MoDNR 2015), dissolved oxygen (mg/L, MoDNR 2016b), specific conductance (µS/cm, MoDNR 2016c), pH (MoDNR 2016d), and temperature (°C, MoDNR 2016e), were measured in the field. The ESP Chemical Analysis Section (**CAS**) conducted analyses for the following: calcium, magnesium, hardness as $CaCO_3$, sulfate, ammonia-nitrogen, nitrate+nitrite-nitrogen, total nitrogen, total phosphorus, chloride, and total suspended solids/non-filterable reside (all parameters reported in mg/L).

Physicochemical water parameters were compared among stations as well as with Missouri's WQS (MoDNR 2014) and USEPA recommendations. Interpretation of acceptable limits in the WQS may be dependent on a stream's classification and beneficial uses as designated in the WQS (MoDNR 2014).

4.3.3 Discharge

Stream flow was measured using a SonTek/YSI FlowTracker® Handheld Acoustic Doppler Velocimeter® at all stations during both sampling seasons in accordance with the SOP MDNR-ESP-113, *Flow Measurements in Open Channels* (MoDNR 2015).

4.4 Quality Assurance/Quality Control (QA/QC)

4.4.1 Field Meters

All field meters used to collect water quality parameters were maintained in accordance with *Quality Control Procedures for Checking Water Quality Field Instruments* (MoDNR 2016f).

4.4.2 Biological Samples

Steps to assure accuracy of organism removal from sample debris were performed consistent with those methods found in the SMSBPP document (MoDNR 2012).

4.4.3 Biological Data Entry

All macroinvertebrate data were entered into the WQMS macroinvertebrate database consistent with *Quality Control Procedures for Data Processing* (MoDNR 2016g).

4.4.4 Duplicate Sample Collection

Duplicate samples are obtained from the same location at essentially the same time as the true sample following procedures in accordance with *Quality Assurance/Quality Control for Environmental Data Collection* (MoDNR 2013). The true samples and the duplicate samples are analyzed for the same set of parameters. A duplicate is used to assess the precision associated with sampling methodology, sample heterogeneity, and analytical procedures (MoDNR 2013). A duplicate sample was collected for physicochemical parameters at Williams Creek station 0.5 during the fall sampling period. Duplicate samples are analyzed and reported independently.

5.0 Results

5.1 Land Use

The land use data in Table 1 provide a comparison between the 12-digit HUC that includes the Williams Creek study reach and the Ozark/Neosho EDU. All Williams Creek stations are located within the same 12-digit HUC.

Table 1
Percent Land Use in Williams Creek
Sampling Stations and the Ozark/Neosho EDU

	12-digit HUC	Urban/ Impervious	Crop-land	Grass-land	Forest-land	Herba-ceous	Wetland/ Open water
Williams Creek	110702070105	6.0	3.7	79.8	7.5	2.3	0.8
Ozark/Neosho EDU	-------	5.3	15.2	52.8	20.4	4.8	1.6

Comparison of land use between the 12-digit HUCs containing the study segments and the Ozark/Neosho EDU showed the study stream contained less cropland and forestland and contained more grassland than the EDU. The percent of non-vegetated, herbaceous, and open water were similar between the EDU and the study stream watershed.

5.2 Stream Habitat Assessment

Habitat assessment scoring results are presented in Table 2. If the study station SHAPP score is $\geq$75 percent of the control station score, the stations are considered to contain comparable habitats to the control station. Comparable habitats should support similar biological communities. All stations scored $\geq$75 percent of the SHAPP control, Mikes Creek. Based on SHAPP scores, it is inferred that the Williams Creek stations have habitats similar to the biological criteria reference stream and, therefore, should support a comparable biological community.

Table 2
Habitat Values and Scores from Stream Habitat Assessments,
Williams and Mikes Creeks

Stream Habitat Parameters	Williams 0.5	Williams 1	Williams 3	Mikes Creek
Habitat Assessment Date	9/22/2015	9/22/2015	9/22/2015	9/24/2015
Epifaunal Substrate/Available Cover	III (8)	I (16)	II (11)	II (15)
Embeddedness	I (17)	I (17)	II (15)	I (16)
Velocity/Depth Regime	I (19)	I (16)	I (19)	II (15)
Sediment Deposition	III (8)	II (12)	II (13)	II (13)
Channel Flow Status	II (13)	II (13)	II (13)	II (12)
Channel Alteration	II (15)	I (18)	I (18)	I (20)
Riffle Quality	II (14)	I (17)	II (13)	II (12)
Left Bank Stability	II (7)	II (6)	II (8)	I (10)
Right Bank Stability	I (10)	I (9)	II (8)	II (6)
Left Bank Vegetative Protection	IV (0)	IV (0)	IV (0)	IV (0)
Right Bank Vegetative Protection	III (3)	IV (1)	IV (0)	IV (0)
Left Bank Riparian Zone Width	III (3)	IV (2)	III (4)	I (10)
Right Bank Riparian Zone Width	III (4)	IV (2)	III (3)	I (10)
Total Habitat Score	**121**	**129**	**125**	**139**
Percent of BIOREF Score	**87.1**	**92.8**	**89.9**	**--**

Habitat parameter categories range from I to IV with category I = optimal, category II = suboptimal, category III = marginal, and category IV = poor. Habitat parameter scores are listed in parentheses and range from 0 to 20 except for vegetative protection and riparian zone categories, which range from 0 to 10.

Epifaunal substrate in Williams Creek varied among the three stations. The downstream station (station 0.5) was made up of smaller material with less than 25 percent of the epifaunal substrate being cobble or large gravel. Station 1 ranked highest in epifaunal substrate with approximately 50 percent. Station 3 ranked suboptimal with nearly 30 percent of the substrate being a mix of cobble or large gravel. All four preferred depth regimes were present at all stations. Embeddedness was low at all stations, and sediment deposition was marginal at station 0.5 but less at the two upstream stations. Channel flow status was suboptimal with the water only filling approximately three-fourths of the channel. Station 0.5 had some channel alterations near the upstream terminus of the reach where the trees had been cleared to accommodate a private airplane runway strip. Riffle quality was best at station 1 with the riffles being nearly as wide as the stream and length extending two times the stream width. However, areas of the streambed and stream banks between the riffles at station 1 were armored. Stations 0.5 and 3 had short riffles that were narrower than the stream width. Bank stability was suboptimal and vegetative

protection was very low to non-existent with poor riparian quality at each station. Stations 0.5 and 1 were bordered by crop fields on either side of the stream. Station 3 was located between Williams Creek Lake (managed by the Missouri Department of Conservation) to the north and Spirit of 76 Park, a maintained public park, to the south. Crop fields and pastureland border much of the stream throughout its entirety.

Mikes Creek, the SHAPP control, had suboptimal epifaunal substrate. Nearly half of the substrate was mixed cobble and large gravel, and the survey reach had low embeddedness overall. Only three of the four depth regimes were present, and there was no apparent channelization. The channel flow status only covered about 80 percent of the stream. Riffle quality was suboptimal at Mikes Creek with the riffles approximately as wide as the stream, but the length was less than two times the width. Bank stability was good, but the banks lacked vegetative protection. The riparian zone was well developed at Mikes Creek.

5.3 Biological Assessment and Macroinvertebrate Community Analyses

Tables 3 and 4 provide scoring criteria and results for the fall and spring index periods, respectively. MSCI scores were calculated by scoring test station biological metrics using the appropriate biological criteria reference stream (**BIOREF**) criteria. An MSCI score of 16-20 is considered fully supporting, 10-14 is partially supporting, and 4-8 is considered non-supporting of the protection of warm water aquatic life designated beneficial use.

Table 3
Metric Values and Scores for Williams Creek Stations, Fall 2015,
Using Ozark/Neosho Biological Criteria

Stations	TR	EPTT	BI	SDI	MSCI	Support
Williams Creek 0.5	85	23	6.0	3.23		
Score	5	3	3	5	16	**Full**
Williams Creek 1	62	18	6.0	3.04		
Score	3	3	3	5	14	**Partial**
Williams Creek 3	77	21	6.0	3.43		
Score	3	3	3	5	14	**Partial**
BIOREF Score=5	>77	>24	<5.5	>2.97	20-16	Full
BIOREF Score=3	77-39	24-12	5.5-7.7	2.97-1.49	14-10	Partial
BIOREF Score=1	<39	<12	>7.7	<1.49	8-4	Non

MSCI Scoring Table (in light gray) developed from BIOREF samples (*n* = 10) TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index.

During the fall, the downstream station, station 0.5, was the only station to score in the fully supporting category. EPTT and BI for this station were suboptimal resulting in a score of 16, which is the lowest value in the fully supporting category. TR and SDI metrics were optimal at this station. Stations 1 and 3 attained a partially supporting MSCI

score of 14. SDI was the only category at these two stations to be in the optimal range; TR, EPTT, and BI were all suboptimal.

Table 4
Metric Values and Scores for Williams Creek Stations, Spring 2016,
Using Ozark/Neosho Biological Criteria

Stations	TR	EPTT	BI	SDI	MSCI	Support
Williams Creek 0.5	92	24	5.8	3.60		
Score	5	3	3	5	16	**Full**
Williams Creek 1	71	17	6.0	3.30		
Score	3	3	3	5	14	**Partial**
Williams Creek 3	82	21	5.9	3.44		
Score	5	3	3	5	16	**Full**
BIOREF Score=5	>72	>27	<5.3	>3.01	20-16	Full
BIOREF Score=3	72-36	27-13	5.3-7.7	3.01-1.51	14-10	Partial
BIOREF Score=1	<36	<13	>7.7	<1.51	8-4	Non

MSCI Scoring Table (in light gray) developed from BIOREF samples (*n* = 12). TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index.

Stations 0.5 and 3 had fully supporting MSCI scores during the spring sampling season. TR and SDI metrics had optimal scores, and EPTT and BI had suboptimal scores. Station 1 had suboptimal TR, EPTT, and BI individual metric scores and an optimal score for SDI, resulting in a partially supporting MSCI score.

The fall 2015 macroinvertebrate community analysis is shown in Table 5. EPT taxa were present at all stations. The total percentage of EPT taxa ranged from 40.5 to 50.3 percent (compared to the BIOREF average of 37.5 percent). Diptera taxa were consistent at all stations, making up 22.6 to 24.8 percent of the macroinvertebrate community (compared to the BIOREF of 13.6 percent). Chironomidae and Baetidae were the most abundant families collected at all three stations. Commonly collected Chironomidae taxa were of the Tanytarsini tribe, including the genera *Rheotanytarsus, Stempellinella, and Tanytarsus*. *Polypedilum flavum* was also abundant at stations 1 and 3. Baetidae was the most abundant mayfly family, and *Baetis* was the most abundant genus within that family at all three stations. Another baetid mayfly, *Diphetor* was collected at stations 0.5 and 3, but it appeared to have been replaced by *Fallceon* (also a baetid) at station 1.

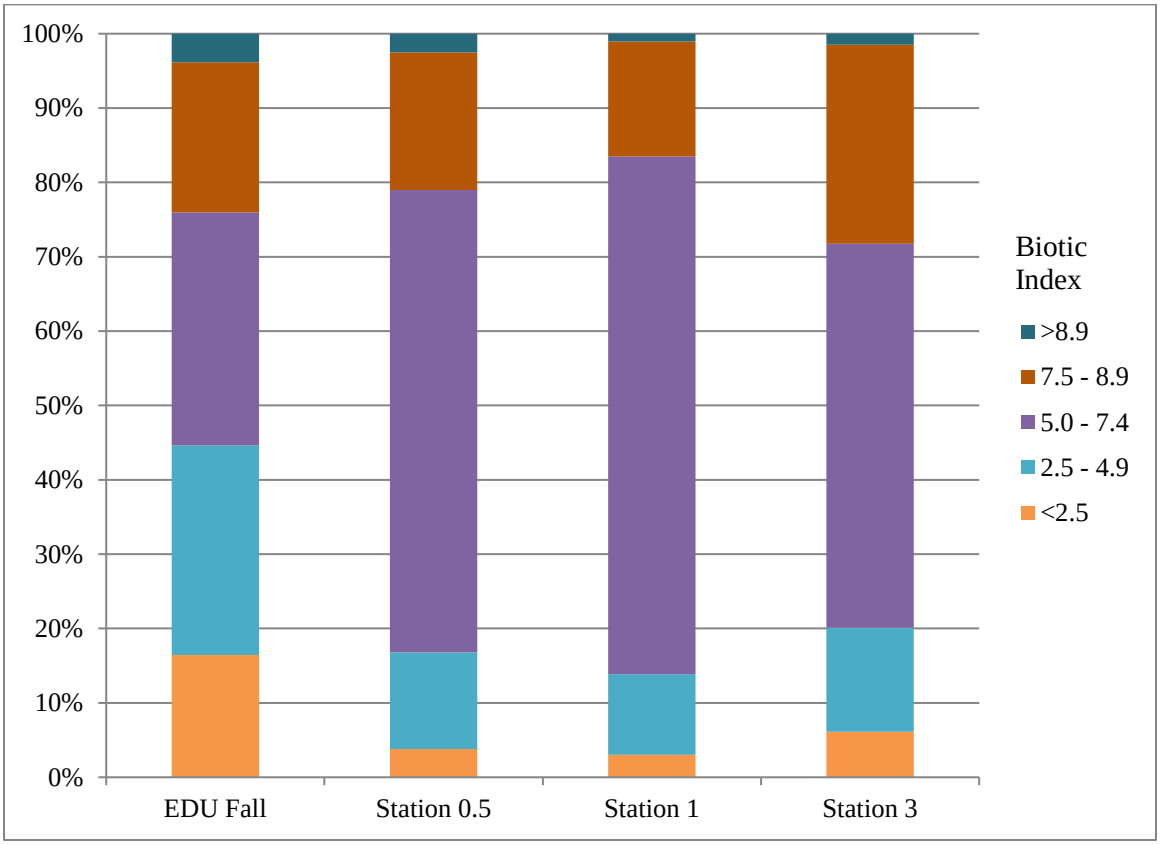
Table 5
Fall 2015 Macroinvertebrate Community Analysis

Stations / Variables	Williams Creek 0.5	Williams Creek 1	Williams Creek 3	Bioref Average
% Ephemeroptera	27.6	30.7	36.2	23.9
% Plecoptera	0.2	0.2	0.3	2.0
% Trichoptera	17.6	9.6	13.8	11.5
% Total EPT	45.4	40.5	50.3	37.5
% Diptera	24.8	22.6	23.0	13.6
% Dominant Macroinvertebrate Families				
Chironomidae	21.1	21.1	17.3	12.9
Baetidae	20.3	23.0	14.0	4.7
Hydropsychidae	13.3	5.7	8.7	5.3
Hyalellidae	8.3	0.0	4.0	8.2
Elmidae	5.5	7.0	7.2	7.5
Asellidae	4.6	6.7	7.3	3.8
Heptageniidae	4.1	4.0	9.4	8.8
Gammaridae	2.2	13.8	0.5	0.6
Caenidae	1.8	2.7	7.6	3.4

The faded text indicates taxa not in the top five dominant taxa for the listed station.

Williams Creek taxa with BI values <4.9 (more sensitive) made up 14 to 20 percent of samples, compared to the reference streams, which had 45 percent. In Williams Creek taxa with BI values ≥5.0 to 8.9 (more tolerant) made up between 78 and 85 percent of samples, whereas reference streams contained 55 percent of taxa within the same category. BIOREF streams have an average of nearly 4 percent of taxa in the very tolerant biotic index category (>8.9), whereas the study sites had no more than 2.5 percent (Figure 4).

Figure 4
Fall 2015 Percent Taxa by Biotic Index Range,
Ozark/Neosho EDU and Williams Creek



Spring 2016 macroinvertebrate community analysis is shown in Table 6. Total EPT taxa ranged from 18.3 to 33.3 percent among the study stations, compared to 39.7 percent of the biological community at BIOREF stations. Ephemeroptera were similar in abundance at station 0.5 when compared to the fall sampling season but less abundant at stations 1 and 3. Plecoptera were more abundant during the spring, and Trichoptera were less abundant. Diptera taxa were present in higher numbers, accounting for 39.7 to 61.4 percent of samples.

Similar to fall, Chironomidae was the dominant family. There was no single genus that was overly abundant; however, several taxa were common at all three stations: *Polypedilum flavum*, *Eukiefferiella*, *Hydrobaenus*, *Cricotopus/Orthocladius* grp., and *Tanytarsus*. Baetidae was second among dominant families at stations 0.5 and 1 and the fifth dominant family at station 3. *Baetis*, *Diphetor*, and *Acentrella* occurred at all stations. Similar to the fall season, *Fallceon* occurred only at station 1. Elmidae was the second dominant family at station 3.

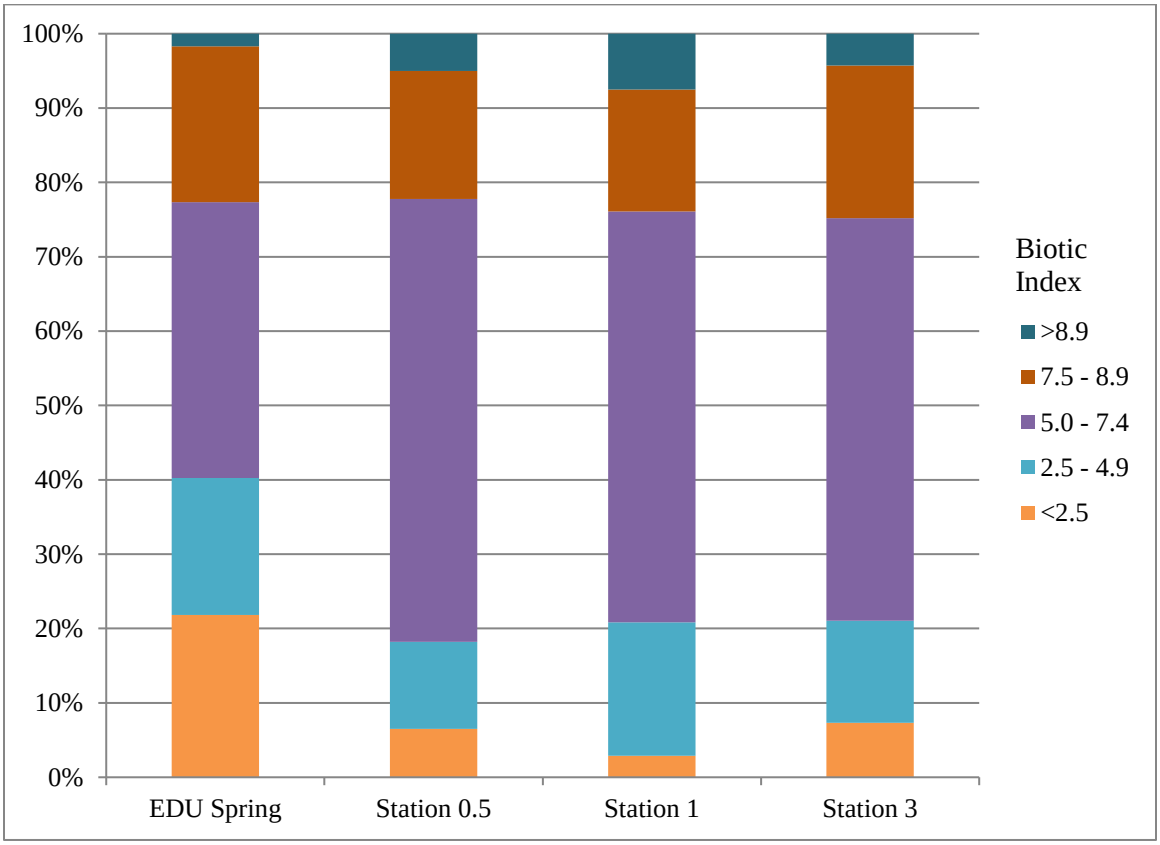
Table 6
Spring 2016 Macroinvertebrate Community Analysis

Stations / Variables	Williams Creek 0.5	Williams Creek 1	Williams Creek 3	Bioref Average
% Ephemeroptera	26.7	23.5	13.1	27.5
% Plecoptera	1.9	1.0	2.8	7.4
% Trichoptera	4.7	0.7	2.4	4.8
% Total EPT	33.3	25.2	18.3	39.7
% Diptera	41.2	39.7	61.4	30.1
% Dominant Macroinvertebrate Families				
Chironomidae	40.1	38.1	60.3	28.6
Baetidae	19.6	21.1	3.7	6.1
Asellidae	9.4	6.9	5.6	14.3
Elmidae	7.1	7.7	7.6	3.7
Heptageniiidae	4.9	1.6	6.4	9.9
Gammaridae	3.6	12.0	0.4	0.4

The faded text indicates taxa not in the top five dominant taxa for the listed station.

As in the fall, Williams Creek spring samples had fewer taxa in the sensitive biotic index category than the BIOREF samples and more taxa in the tolerant biotic index range. Williams Creek taxa in the BI category <4.9 made up 18 to 21 percent of samples, compared to the reference streams, which had 40 percent in this category. In Williams Creek, taxa with BI values ≥5.0 – 8.9 ranged from 79 to 82 percent. In comparison, the reference streams contained 60 percent of taxa within the same category. Reference streams had less than half the abundance of taxa in the very tolerant (>8.9) biotic index category than the study stream (Figure 5).

Figure 5
Spring 2016 Percent Taxa by Biotic Index Range,
Ozark/Neosho EDU and Williams Creek



5.4 Physicochemical Water Parameters

Flow and *in situ* water quality results are presented in Tables 7 and 8. During the fall sampling, station 1 had slightly higher dissolved oxygen and temperature values than the remaining stations. Dissolved oxygen levels ranged from 7.13 mg/L to 9.47 mg/L. pH was nearly equal among stations, and all values were within the WQS criterion range of 6-9. Temperature was approximately 1.5 °C higher at station 1 than the other two stations. Discharge values were three times higher at the downstream station when compared to the upstream station, and discharge at station 1 was more than double that of station 3. Conductivity was slightly lower at the upstream station compared to the remaining downstream stations.

Table 7
Fall 2015 *In Situ* Water Quality Measurements and Flow Measurements

Stations / Parameters	Williams Creek 0.5a	Williams Creek 0.5b	Williams Creek 1	Williams Creek 3
Sampling time and date	1315h; 9/22	1319h; 09/22	1540h; 9/22	0850h; 9/23
Dissolved Oxygen (mg/L)	7.88	7.91	9.47	7.13
pH (su)	7.8	7.7	7.7	7.8
Specific Conductance (µS/cm)	404	409	420	358
Temperature (°C)	18.7	18.4	20.3	18.7
Turbidity (NTU)	2.8	3.1	3.2	1.9
Flow (cfs)	27.4	27.9	18.1	8.1

Similar to fall samples, station 1 had higher dissolved oxygen and temperature values than the remaining sites in the spring (Table 8). Dissolved oxygen levels ranged from 9.33 mg/L to 11.53 mg/L at the three stations. pH was similar among stations, and all values were within the WQS criterion range of 6-9. Temperature values ranged from 13.6 to 15.0 °C. As in the fall, discharge increased more than expected from upstream to downstream stations. Discharge was almost four times higher at station 0.5 than at station 3. Similar to fall, station 1 had roughly double the flow compared to station 3 upstream. Station 3 conductivity again was slightly lower than the downstream stations.

Table 8
Spring 2016 *In Situ* Water Quality Measurements and Flow Measurements

Stations / Parameters	Williams Creek 0.5	Williams Creek 1	Williams Creek 3
Sampling time and date	1415h; 3/16	1555h; 3/16	1700h; 3/16
Dissolved Oxygen (mg/L)	9.33	11.53	10.17
pH (su)	7.9	8.2	8.0
Specific Conductance (µS/cm)	342	359	296
Temperature (°C)	13.6	15.0	14.1
Turbidity (NTU)	3.4	3.8	3.3
Flow (cfs)	30.1	16.7	7.9

Although there are currently no nutrient criteria in place for Missouri streams and rivers, the nutrient concentrations for each season were compared to the USEPA's December 2000 Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion IX (USEPA 2000). USEPA's recommended values for the Ozark Highlands are 0.24 mg/L nitrate + nitrite, 0.38 mg/L total nitrogen, 0.006 mg/L total phosphorus, and 1.42 NTU turbidity (turbidity values are reported in the *in situ* tables above). Water chemistry concentrations are presented in Tables 9 and 10.

During the fall sampling season, nitrate+nitrite and total nitrogen were much higher than the EPA recommended values. Total phosphorus and turbidity were also elevated but not

to the degree of nitrate+nitrite and total nitrogen. Ammonia as N, sulfate, and chloride all were within Water Quality Standards.

Table 9
Fall 2015 Water Chemistry Concentrations

Stations / Parameters	Williams Creek 0.5a	Williams Creek 0.5b	Williams Creek 1	Williams Creek 3
Sampling time and date	1315h; 9/22	1319h; 09/22	1540h; 9/22	0850h; 9/23
Nitrate+Nitrite as N (mg/L)	2.98*	2.85*	2.85*	2.62*
Total Nitrogen (mg/L)	3.02	2.98	3.10	2.77
Total Phosphorus (mg/L)	0.17	0.18	0.29	0.06
Ammonia as N (mg/L)	0.09	0.03	<0.03 ND	<0.03 ND
Sulfate (mg/L)	8.63	8.51	9.16	6.73
Chloride (mg/L)	15.5	15.6	19.1	10.6
Total Suspended Solids (mg/L)	<5.0 ND	<5.0 ND	<5.0 ND	<5.0 ND

* Sample was diluted during analysis
ND = not detected at reported value

During the spring sampling season, water chemistry concentrations were similar to the fall values. Nitrate+nitrite and total nitrogen were greatly elevated. Total phosphorus and turbidity were also elevated but to a lesser degree than nitrate+nitrite and total nitrogen. Total phosphorus values were higher downstream of the WWTF. Ammonia as N, sulfate, and chloride were within Water Quality Standards.

Table 10
Spring 2016 Water Chemistry Concentrations

Stations / Parameters	Williams Creek 0.5	Williams Creek 1	Williams Creek 3
Sampling time and date	1415h; 3/16	1555h; 3/16	1700h; 3/16
Nitrate+Nitrite as N (mg/L)	2.08*	1.94	1.87*
Total Nitrogen (mg/L)	2.37	2.17	2.11
Total Phosphorus (mg/L)	0.12	0.19	0.04
Ammonia as N (mg/L)	<0.03 ND	<0.03 ND	<0.03 ND
Sulfate (mg/L)	7.21	9.44	5.79
Chloride (mg/L)	14.2	18.9	10.8
Total Suspended Solids (mg/L)	<5.0 §,ND	<5.0 §,ND	<5.0 §,ND

* Sample was diluted during analysis
§ Estimated Value, QC Data Outside Limits
ND not detected at reported value

6.0 Comparison to 1997 Bioassessment

Two Williams Creek stations were sampled during the spring and fall of 1997. Station 1 was located at County Road 1117 and station 2 was located 0.2 miles downstream of the wastewater facility's outfall. The current bioassessment also sampled at County Road 1117. Tables 11 and 12 display the MSCI scores from the spring and fall of 1997.

The TR and EPTT metrics were lower during the 1997 bioassessment compared to the present study. Although the individual scores for the BI metric did not change, the current BI metric has improved with values lower than the 1997 study. The SDI metric was higher during the present study as well. Although the County Road 1117 sample site scored in the partially supporting category during both studies, the current MSCI score was higher due to improved individual metric scores.

Table 11
Metric Values and Scores for Williams Creek Stations, Spring 1997,
Using Ozark/Neosho Biological Criteria

Stations	TR	EPTT	BI	SDI	MSCI	Support
Williams Ck 1	43	7	7.0	1.98		
Score	3	1	3	3	10	**Partial**
Williams Ck 2	57	12	6.7	2.50		
Score	3	1	3	3	10	**Partial**
BIOREF Score=5	>72	>27	<5.3	>3.01	20-16	Full
BIOREF Score=3	72-36	27-13	5.3-7.7	3.01-1.51	14-10	Partial
BIOREF Score=1	<36	<13	>7.7	<1.51	8-4	Non

MSCI Scoring Table (in light gray) developed from BIOREF samples (*n* = 12) TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index.

Table 12
Metric Values and Scores for Williams Creek Stations, Fall 1997,
Using Ozark/Neosho Biological Criteria

Stations	TR	EPTT	BI	SDI	MSCI	Support
Williams Ck 1	48	12	6.6	2.33		
Score	3	3	3	3	12	**Partial**
Williams Ck 2	53	5	7.0	2.73		
Score	3	1	3	3	10	**Partial**
BIOREF Score=5	>77	>24	<5.3	>2.97	20-16	Full
BIOREF Score=3	77-39	24-12	5.5-7.7	2.97-1.49	14-10	Partial
BIOREF Score=1	<39	<12	>7.7	<1.49	8-4	Non

MSCI Scoring Table (in light gray) developed from BIOREF samples (*n* = 10). TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index.

During the 1997 bioassessment, Asellidae, Crangonyctidae, and Gammaridae were the most common families collected during the spring. Those three families made up almost 75 percent of the taxa at station 1 and 60 percent of the taxa at station 2. EPT taxa were minimal. Trichoptera were lacking at station 1, and Ephemeroptera and Plecoptera only contributed 2 percent of taxa to the macroinvertebrate community. All three of the EPT orders had representatives present at station 2 but only contributed 5.7 percent of the community.

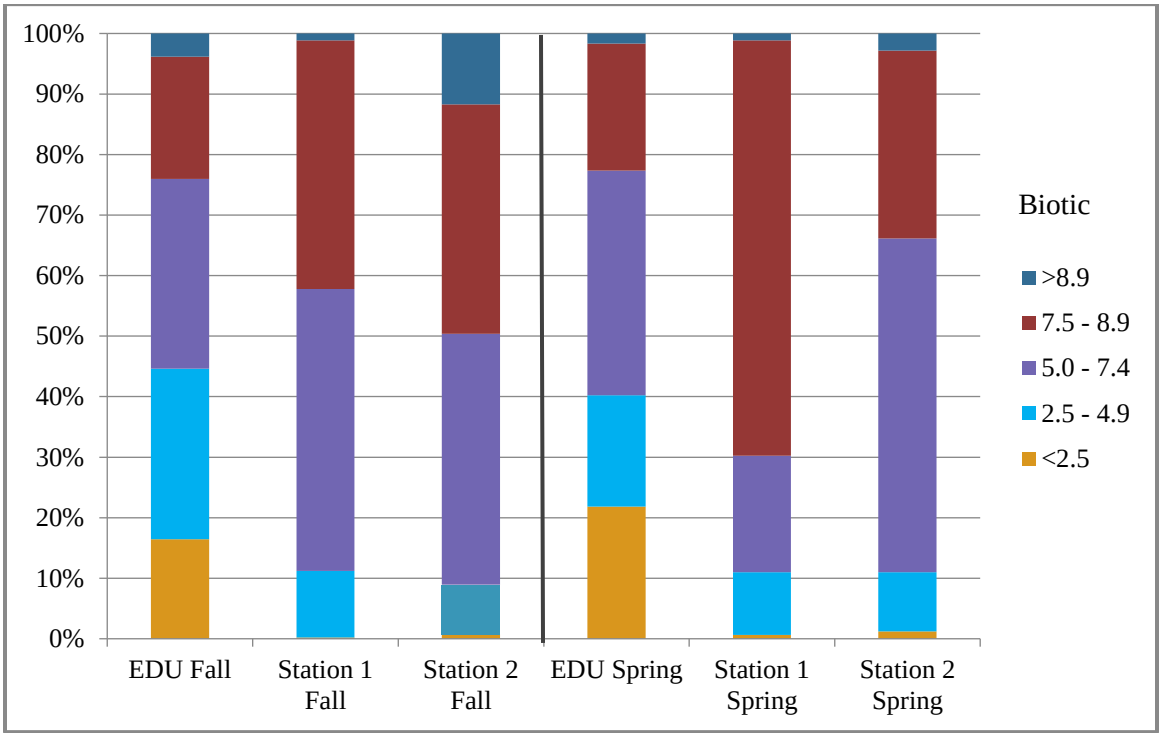
In fall 1997, Asellidae and Gammaridae were the most commonly collected taxa. These two taxa accounted for 55 percent of the sample at station 1 and almost 40 percent at station 2. EPT taxa made up more of the station 1 sample in fall, mainly due to a higher percentage of Ephemeroptera. Trichoptera were present at both stations in fall, but they were rare. Trichoptera made up 1.1 percent of the station 1 sample, and a single caddisfly individual was present in the station 2 sample. Plecoptera were absent from both stations in fall.

When comparing the two seasons, Plecoptera were present in low abundance at both stations in spring but lacking entirely at both stations in fall. Ephemeroptera were more prevalent at station 1 during the fall (15.8 percent of the sample) than spring (1.8 percent). At station 2, however, Ephemeroptera were present in similar abundance during both seasons (5.5 percent in the spring and 5.1 percent in the fall). Trichoptera made up approximately 1 percent of the station 1 fall sample, but they were absent from the station 1 spring sample. Trichoptera was represented by a single specimen in both spring and fall station 2 samples.

Figure 6 illustrates the percent taxa by biotic index range for the spring and the fall bioassessments in 1997. Williams Creek samples had fewer taxa in the sensitive biotic index range than the BIOREF samples and more taxa in the tolerant range during both seasons. During the spring, Williams Creek taxa in the BI category <4.9 made up

approximately 10 percent of samples at both stations compared to 40 percent in BIOREF samples. Taxa with BI values ≥5.0 – 8.9 composed approximately 87 percent of samples at both stations compared to 60 percent in the reference streams. Very tolerant taxa (BI >8.9) ranged from 1 to 3 percent of Williams Creek samples. Reference streams had less than 2 percent of the very tolerant taxa. During the fall, taxa in the BI category <4.9 made up approximately 10 percent of samples, but BIOREF streams had approximately 45 percent of taxa in this category. Taxa in the mid-ranged biotic index category made up 79 to 87 percent of samples, whereas BIOREF samples had 51 percent. The very tolerant taxa ranged from 1 to 12 percent in the fall compared to the BIOREF streams of 4 percent.

Figure 6
Spring and Fall 1997 Percent Taxa by Biotic Index Range,
Ozark/Neosho EDU and Williams Creek



7.0 Discussion

7.1 Land Use

Williams Creek originates in central Lawrence County. The headwaters extend a few miles east of Interstate 44, a major east-west corridor across the state. The stream flows directly through Mount Vernon and continues west to the confluence of Spring River. The study area bracketed the Mount Vernon WWTF. The downstream station was located approximately 1.7 miles upstream of the confluence with Spring River.

The area is populated with industrial, commercial, and residential properties. The watershed for the study stream is approximately 55 square miles and mostly comprises grassland used as pastures (80 percent). The EDU has more diverse land use with 53 percent grassland, 20 percent forest, and 15 percent cropland. The increased grassland (pasture areas) in the Williams Creek watershed resulted in some areas of the stream having little to no riparian corridor. Landscape alterations (such as urbanization and agricultural lands) affect the quantity and quality of water entering a water body by altering the natural flow of water, making streams and rivers more susceptible to extreme flooding events (Tang et al. 2005; Walsh et al. 2005). Extreme flooding events may be partially responsible for the armored streambed at station 1 and the decreased quality of instream habitat for macroinvertebrate colonization.

7.2 Stream Habitat Assessment

The SHAPP scores of the study stations were comparable to the control stream with one notable difference: riparian coverage. The riparian zone had marginal or poor rankings at all Williams Creek stations. By comparison, the control stream had a well-developed riparian corridor on both sides of the stream. The downstream station had sections of the riparian area cleared of trees near the road to accommodate a private runway. The land between station 1 and the WWTF was pastureland (cattle were present at the time of sampling), and the stream through this area had negligible riparian vegetation for almost 0.5 miles. The upstream station had a poor riparian corridor due to its location in town and proximity to the public park. Riparian areas that were present at the study stations were narrow. Riparian vegetation positively influences stream ecosystems directly by providing shading, leaf litter inputs, woody debris, and bank stability and indirectly by reducing inputs of nutrients and other contaminants entering the system from the surrounding landscape (Burrell et al 2014). Intact riparian zones along stream banks are important in maintaining the stream health, stream habitat, and healthy water quality (Allan 2004, Waite and Van Metre 2017).

Williams Creek not only lacked sufficient riparian coverage, but it also lacked high quality instream habitat for macroinvertebrate communities. Although the substrate of the stream consisted of areas with cobble and coarse gravel, the stream had minimal submerged vegetation, woody debris, and undercut banks. Instream habitat variables as well as catchment variables have been shown to influence aquatic communities (Wang et al. 2007, Burdon et al. 2013). Cobble and coarse gravel were present in the stream but ranked marginal at station 0.5. Station 1 had the highest amount of available epifaunal substrate at 50 percent but also had extensive areas of the substrate that were armored. Riffle quality was marginal at two stations and sediment deposition was marginal to suboptimal. A study on aquatic invertebrate conditions throughout the Corn Belt of the United States showed that instream stressors were dominant factors driving macroinvertebrate communities (Waite and Van Metre 2017).

7.3 Biological Assessment and Macroinvertebrate Community Analysis

Based on Ozark/Neosho EDU biological criteria reference data, the MSCI scores varied. The downstream station, 0.5, is the only station that attained a fully supporting MSCI score in both sampling seasons. However, the station scored a 16, which is the lowest possible score in that category. EPT taxa were present at all stations, but not enough to attain an optimal metric score. Station 1 attained a partially supporting score for both seasons with the lowest EPTT and TR values of all the stations sampled. Station 3 was partially supporting in the fall and fully supporting in the spring due to higher taxa richness in the spring. Biotic integrity has been shown to be associated with local instream habitat variables (Lammert and Allan 1999, Burdon et al. 2013). Lammert and Allan (1999) showed that channel morphology and substrate were vital to healthy macroinvertebrate communities. A study of agricultural streams in New Zealand found that a decrease of instream habitat availability through sedimentation decreased macroinvertebrate biodiversity and that sensitive taxa are strongly associated with benthic habitat quality (Burdon et al. 2013).

Chironomidae was the most abundant family collected. A study in the Piedmont region of North Carolina showed streams in landscapes dominated by agriculture had low EPTT numbers and higher taxa richness of tolerant taxa, particulary Chironomidae (Lenat and Crawford 1994). Although Baetidae was the second most commonly collected family among stations, the mayfly taxa in this family tended to have mid-range BI values: *Baetis* (BI = 6), *Diphetor* (BI = 5), *Fallceon* (BI = 6), and *Acentrella* (BI = 4). Most of the commonly collected taxa at each station were taxa with mid-range BI values (examples include Cheumatopsyche [BI = 6.6], *Hyalella azteca* [BI = 7.9], *Stenelmis* [BI = 5.4], and *Lirceus* [BI = 7.7]). Although SDI was optimal at all stations in both seasons, this diversity appears to be distributed among taxa with mid-range BI values. The SDI is a measure of community composition accounting for both abundance and evenness (Shannon and Weaver 1949). Similar dominant taxa were present throughout the study stream stations but collected in lesser abundance at the BIOREF reaches, which had a more evenly distributed community among the BI ranges. Streams in urban and agricultural areas tend to have macroinvertebrate communities with reduced biotic richness and increased dominance of tolerant taxa (Lenat and Crawford 1994, Walsh et al. 2005).

Although Williams Creek has failed to meet fully supporting status, the creek has shown improvement since the 1997 bioassessment as evidenced by individual components of the MSCI score having improved. During the 1997 bioassessment, the most abundant taxa were non-insect taxa (Gammaridae, Asellidae, and Crangonyctidae). Currently, more taxa overall are present in the stream, including EPTT and additional insect taxa. The BI vales have decreased, indicating that although organic pollution may still be an issue, it has improved since the 1997 study. In addition, SDI values have improved. An emphasis on watershed improvements may be beneficial to the entire macroinvertebrate community.

7.4 Physicochemical Water Parameters

Water quality measurements were largely consistent among stations for each sampling season. Temperature and dissolved oxygen were slightly different among stations, but these differences were likely due to time of day. Flow measurements increased more than expected between stations 3 and 1 during both seasons. Although the Mount Vernon WWTF outfall discharges upstream of station 1, neither the actual flow (0.71 million gallons per day [**MGD**] = 1.1 cfs) nor the design flow (1.35 MGD = 2.1 cfs) of the facility would account for the flow difference between stations in either season.

There is one unnamed tributary located between stations 3 and 1 that is classified as a losing stream. The tributary begins within the city limits of Mount Vernon and flows through town until reaching Williams Creek. Although there are no springs in this area contributing flow to Williams Creek, the study reach is classified as a gaining stream, starting upstream of station 3 continuing to approximately 1 mile downstream of station 1. A gaining stream is a stream in which the bottom of the channel is lower than the level of the surrounding groundwater table. Groundwater seepage is likely adding to the overall flow of Williams Creek throughout the study reach. This groundwater influx may also contribute to the difference in conductivity readings observed between stations 3 and 1 during both seasons. Despite the possible groundwater interaction, however, temperature was unaffected between station 3 and the downstream sites.

Chloride concentrations also increased notably between stations 3 and 1. Chloride levels were approximately twice as high at station 1 (immediately downstream of Mount Vernon), compared to the upstream station 3, which is near the boundary of Mount Vernon. Higher chloride concentrations in urban streams are typically associated with late winter and early spring conditions as snow melts and spring rains carry road treatment chemicals into receiving streams (Hubbart et al. 2017). However, both seasons exhibited increased chloride concentrations. This observation is consistent with observations made by Hubbart et al. (2017), who noted that soils and groundwater, under certain conditions, serve as a source of chloride. The likely source of chloride accumulation over time is via salt application during the winter months. Although chloride concentrations increased between the two stations, they did not exceed the acute or chronic standard.

Nutrient levels were elevated when compared to USEPA recommended values. Streams in agricultural and urban settings often have elevated concentrations of nutrients and contaminants (Allan 2004, Walsh et al. 2005). Total phosphorus levels were higher downstream of the WWTF. During the fall, total phosphorus was 0.06 mg/L upstream of the WWTF and as high as 0.29 mg/L downstream of the facility. During the spring, total phosphorus at station 3 was 0.04 mg/L; downstream of the WWTF, total phosphorus was 0.19 mg/L at station 1 and 0.12 mg/L at station 0.5. Nitrate+nitrite and total nitrogen were elevated at all three stations but were not noticeably elevated downstream of the WWTF. Nitrate+nitrite values were approximately 11 times higher than USEPA's recommended criteria and total nitrogen was approximately seven times higher. High

levels of nutrients result in degraded aquatic communities (Dodds et al. 2009, Waite and Van Metre 2017, Wang 2007). Excessive nutrients threaten aquatic communities by causing algal blooms and eutrophication, and they have been identified as a major reason why water quality objectives, such as support of aquatic life, fail (USEPA 2000). Algae were present throughout the stream but did not appear to be excessive at any particular station during the time of sampling.

8.0 Summary

Tests of the null hypotheses resulted in the following conclusions.

1) Land cover characteristics in the Williams Creek watershed will be similar to the land cover characteristics of the Ozark/Neosho EDU. This hypothesis is rejected. The study stream had less than half the amount of cropland and forestland than the EDU and 27 percent more grassland.

2) Stream habitat assessment scores of Williams Creek will be similar to the stream habitat scores of Mikes Creek, a BIOREF stream in the Ozark/Neosho EDU. This hypothesis is accepted. The SHAPP scores of the study stations all scored >75% of the SHAPP control stream.

3) The macroinvertebrate community in Williams Creek will be similar among longitudinally separate reaches of Williams Creek. This hypothesis is rejected. The MSCI scores for the three stations varied over the seasons, ranging from partially supporting to fully supporting.

4) The macroinvertebrate community in Williams Creek will be similar to the macroinvertebrate community of BIOREF streams in the Ozark/Neosho EDU. This hypothesis is rejected. Only the downstream station attained fully supporting status during both seasons; however, it was the lowest possible fully supporting MSCI score.

5) Physicochemical water quality of Williams Creek will meet Missouri WQS (MoDNR 2014). This hypothesis is accepted. All water chemistry parameters were within the limits established by the WQS.

6) Physicochemical water quality parameters in Williams Creek will meet United States Environmental Protection Agency's (**USEPA**) recommendations. This hypothesis is rejected. Nitrate+nitrite, total nitrogen, and total phosphorus were elevated when compared with USEPA's recommended values for the Ozark Highlands.

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Appendix A

Invertebrate Database Bench Sheet Report:
Williams Creek, Lawrence Co, MO
Grouped by Season and Station

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15138], Station #0.5, Sample Date: 9/22/2015 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	4	2	
AMPHIPODA			
Gammarus	5	20	8
Hyalella azteca			123
Stygobromus	2	1	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae		4	
Menetus			5
BRANCHIOBDELLIDA			
Branchiobdellida	1		
COLEOPTERA			
Dubiraphia		4	16
Optioservus sandersoni	36		
Psephenus herricki	14	3	
Scirtidae			2
Stenelmis	15	4	6
DECAPODA			
Faxonius macrus	1	1	1
Faxonius neglectus	-99	-99	3
DIPTERA			
Ablabesmyia		27	1
Ceratopogoninae		1	
Chironomidae		3	
Chironomus		1	
Chrysops		2	
Corynoneura		1	
Cricotopus bicinctus			5
Cricotopus sylvestris grp		2	
Cricotopus/Orthocladius		2	3
Cryptochironomus	1	13	
Cryptotendipes		5	
Dicrotendipes		4	
Hemerodromia	1		1
Microtendipes		8	
Nanocladius			1
Parametriocnemus		1	
Paratendipes		18	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15138], Station #0.5, Sample Date: 9/22/2015 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Phaenopsectra		1	
Polypedilum flavum	18		1
Polypedilum illinoense grp			4
Polypedilum scalaenum grp		7	
Procladius		1	
Rheotanytarsus	5	1	81
Simulium	47		2
Stempellinella	10	39	5
Tabanus	-99		
Tanytarsus	5	23	3
Thienemannimyia grp.	1		11
Xylotopus		1	
EPHEMEROPTERA			
Acentrella	1		
Acerpenna			1
Baetis	288		1
Caenis anceps	2	1	
Caenis latipennis		22	2
Diphetor	7		1
Ephemera		1	
Heptageniidae	2	1	
Hexagenia		1	
Leptophlebiidae		17	2
Leucrocuta	27		
Maccaffertium modestum	8		
Procloeon		1	
Stenacron	7	13	
Stenonema femoratum		2	
Tricorythodes		1	
HAPLOTAXIDA			
Haplotaxis		1	
ISOPODA			
Lirceus	65	3	
LEPIDOPTERA			
Noctuidae		1	
LUMBRICINA			
Lumbricina		-99	
LUMBRICULIDA			
Lumbriculidae		1	
MEGALOPTERA			

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15138], Station #0.5, Sample Date: 9/22/2015 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Corydalus	-99		
NEOTAENIOGLOSSA			
Elimia	8	1	8
Hydrobiidae	1	3	3
ODONATA			
Argia			8
Calopteryx			10
Enallagma			9
Gomphidae	1		
Hetaerina			10
PLECOPTERA			
Acroneuria	3		
TRICHOPTERA			
Ceratopsyche morosa grp	4		
Cheumatopsyche	188		5
Chimarra	60		
Lype diversa		1	
Oecetis			1
Polycentropus		1	
TRICLADIDA			
Planariidae	1		
TUBIFICIDA			
Limnodrilus hoffmeisteri		1	
Tubificidae	3	15	
VENEROIDA			
Corbicula	-99	1	1
Pisidiidae	5	1	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15139], Station #1, Sample Date: 9/22/2015 3:40:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		7	
AMPHIPODA			
Gammarus	33	29	106
Stygobromus	3	10	
BASOMMATOPHORA			
Ancylidae		1	
Menetus			1
COLEOPTERA			
Dubiraphia		1	1
Optioservus sandersoni	26	12	2
Psephenus herricki	10	2	
Stenelmis	10	29	4
DECAPODA			
Faxonius macrus	1	1	
Faxonius neglectus	-99	-99	-99
DIPTERA			
Ablabesmyia		4	
Ceratopogoninae		1	
Corynoneura	1		
Cryptochironomus		5	
Eukiefferiella	1		
Micropsectra			4
Microtendipes	2	2	
Parametriocnemus	1	1	
Paratanytarsus			1
Paratendipes		1	
Polypedilum aviceps	2		
Polypedilum flavum	12		
Polypedilum illinoense grp			1
Polypedilum scalaenum grp		2	
Rheotanytarsus	1		45
Simulium	16	1	
Stempellinella	45	77	13
Stenochironomus		2	
Tanytarsus	8	12	3
Thienemanniella		3	
Thienemannimyia grp.	4		5
EPHEMEROPTERA			
Acerpenna		1	1

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15139], Station #1, Sample Date: 9/22/2015 3:40:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Baetis	185	3	7
Caenis anceps	2	16	
Caenis latipennis		14	1
Choroterpes		5	
Ephemera		-99	
Fallceon	51	1	31
Leptophlebiidae	1	4	
Leucrocuta	12	2	
Maccaffertium pulchellum	2		
Procloeon		1	
Stenacron	15	9	
Stenonema femoratum	1	7	1
Tricorythodes		1	
HEMIPTERA			
Microvelia			1
ISOPODA			
Caecidotea (Blind & Unpigmented)	1	4	
Lirceus	41	12	24
LUMBRICINA			
Lumbricina		-99	
LUMBRICULIDA			
Lumbriculidae	3	1	
NEOTAENIOGLOSSA			
Elimia	2		5
ODONATA			
Argia		1	1
Calopteryx			5
Hetaerina			2
PLECOPTERA			
Acroneuria	2		
TRICHOPTERA			
Cheumatopsyche	66		4
Chimarra	44		
Polycentropus	1	2	
TRICLADIDA			
Planariidae	28	5	8
TUBIFICIDA			
Tubificidae		12	
VENEROIDA			

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15139], Station #1, Sample Date: 9/22/2015 3:40:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Pisidiidae		6	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15140], Station #3, Sample Date: 9/23/2015 8:50:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1	2	1
AMPHIPODA			
Crangonyx	1	5	
Gammarus	1	4	2
Hyalella azteca			57
Stygobromus	3	3	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	-99	
BASOMMATOPHORA			
Ancylidae			6
Menetus			4
COLEOPTERA			
Dubiraphia		2	5
Macronychus glabratus			3
Optioservus sandersoni	1		
Psephenus herricki	8	12	1
Stenelmis	61	19	12
DECAPODA			
Faxonius macrus	-99		
Faxonius neglectus		1	1
Faxonius virilis			-99
DIPTERA			
Ablabesmyia		9	11
Chironomidae			1
Cricotopus bicinctus			5
Cricotopus sylvestris grp		2	
Cricotopus/Orthocladius			2
Cryptochironomus	1	2	
Dicrotendipes		2	3
Hemerodromia	1		
Labrundinia			3
Microtendipes	1	4	5
Nilotanypus	2		
Parametriocnemus	3		
Paratanytarsus			10
Polypedilum aviceps	5		
Polypedilum flavum	52		
Polypedilum illinoense grp	1		4
Rheotanytarsus		1	15

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15140], Station #3, Sample Date: 9/23/2015 8:50:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Simulium	77		4
Stempellinella	10	5	6
Stenochironomus		2	
Tabanus		-99	
Tanytarsus	12	5	35
Thienemanniella	3		
Thienemannimyia grp.	12	4	8
Zavrelimyia (Paramerina)			3
EPHEMEROPTERA			
Acerpenna		2	4
Baetis	169		4
Caenis anceps	43	33	
Caenis latipennis		17	17
Choroterpes		26	
Diphetor	23		
Eurylophella			2
Isonychia	2		
Leptophlebiidae		39	2
Leucrocuta		4	
Maccaffertium modestum	57		4
Stenacron	1	26	2
Stenonema femoratum		39	2
Tricorythodes		1	1
ISOPODA			
Caecidotea (Blind & Unpigmented)		10	
Lirceus	63	24	8
LUMBRICINA			
Lumbricina		3	
LUMBRICULIDA			
Lumbriculidae		1	
MEGALOPTERA			
Sialis		2	
NEOTAENIOGLOSSA			
Elimia	1		1
Hydrobiidae		2	
ODONATA			
Argia	2	1	8
Calopteryx			8
Enallagma			6

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [15140], Station #3, Sample Date: 9/23/2015 8:50:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Hetaerina			2
Ischnura			1
PLECOPTERA			
Acroneuria	1	-99	
Agnetina flavescens	3		
TRICHOPTERA			
Cheumatopsyche	122		3
Chimarra	53		
Helicopsyche	1		
Polycentropus	1	2	
Triaenodes			16
TRICLADIDA			
Planariidae	7	7	7
TUBIFICIDA			
Tubificidae		4	
VENEROIDA			
Pisidiidae		1	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16057], Station #0.5, Sample Date: 3/16/2016 2:20:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	1
AMPHIPODA			
Crangonyx			4
Gammarus	12	27	14
Hyalella azteca			5
Stygobromus		5	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae	1		
BRANCHIOBDELLIDA			
Branchiobdellida		1	2
COLEOPTERA			
Dubiraphia		3	4
Optioservus sandersoni	49	10	1
Psephenus herricki	6	2	
Stenelmis	19	7	12
DECAPODA			
Faxonius macrus	1	-99	
Faxonius neglectus	1	1	-99
DIPTERA			
Ablabesmyia		6	3
Brillia		1	1
Ceratopogoninae	4	5	
Chrysops	-99		
Corynoneura		1	10
Cricotopus bicinctus	3	2	23
Cricotopus/Orthocladius	4	13	22
Cryptochironomus		6	
Cryptotendipes		7	
Dicrotendipes		7	2
Diptera		1	
Eukiefferiella	25	3	12
Hemerodromia	3		
Hexatoma	-99	1	
Hydrobaenus		24	23
Labrundinia			1
Micropsectra		5	7
Microtendipes		2	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16057], Station #0.5, Sample Date: 3/16/2016 2:20:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Nanocladius			2
Parakiefferiella			1
Paralauterborniella		1	
Parametriocnemus		4	
Paratanytarsus		6	9
Paratendipes		26	3
Phaenopsectra		2	
Polypedilum aviceps	9		
Polypedilum fallax grp		2	
Polypedilum flavum	93	1	
Polypedilum illinoense grp		1	1
Polypedilum scalaenum grp		11	
Rheocricotopus	1	1	
Rheotanytarsus	11	4	40
Simulium	2		
Stempellina		1	
Stempellinella	17	6	6
Tabanus	-99		
Tanytarsus	22	24	14
Thienemanniella			22
Thienemannimyia grp.	24	6	7
Tipula	-99		
Tvetenia bavarica grp	2		
EPHEMEROPTERA			
Acentrella	18		
Acerpenna	2		
Baetis	83		5
Caenis latipennis		24	
Callibaetis			6
Centroptilum		3	5
Diphetor	147	4	17
Ephemera	-99	-99	
Leptophlebia			7
Leptophlebiidae		1	
Leucrocuta	20	11	1
Maccaffertium modestum	11	3	
Stenacron	1	21	
Stenonema femoratum		5	
HAPLOTAXIDA			
Haplotaxis		1	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16057], Station #0.5, Sample Date: 3/16/2016 2:20:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
ISOPODA			
Caecidotea (Blind & Unpigmented)		2	
Lirceus	51	53	33
LEPIDOPTERA			
Petrophila	-99		
LUMBRICINA			
Lumbricina		-99	
NEOTAENIOGLOSSA			
Elimia	8		2
ODONATA			
Argia	-99		
Calopteryx			4
Stylogomphus albistylus			-99
PLECOPTERA			
Acroneuria	3	-99	
Leuctridae	1		
Perlesta	23		1
TRICHOPTERA			
Agapetus	12		
Ceratopsyche morosa grp	1	1	
Cheumatopsyche	34	1	2
Chimarra	10		
Helicopsyche	2	2	
Hydropsyche	2		
Polycentropus		2	1
TRICLADIDA			
Planariidae	5		1
TUBIFICIDA			
Limnodrilus hoffmeisteri		1	
Tubificidae	5	12	
VENEROIDA			
Pisidiidae	7	1	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16058], Station #1, Sample Date: 3/16/2016 3:55:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1	3	
AMPHIPODA			
Crangonyx			5
Gammarus	19	40	102
Stygobromus		4	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	
BRANCHIOBDELLIDA			
Branchiobdellida			1
COLEOPTERA			
Dubiraphia		2	
Optioservus sandersoni	49	8	4
Psephenus herricki	1	1	
Stenelmis	22	10	9
DECAPODA			
Faxonius macrus		-99	
Faxonius neglectus		-99	-99
DIPTERA			
Ablabesmyia		11	1
Brillia		1	3
Ceratopogoninae	1	1	
Chironomidae			1
Cladotanytarsus		1	
Corynoneura	3	2	2
Cricotopus bicinctus	2	2	11
Cricotopus/Orthocladius	10	5	29
Cryptochironomus		7	
Dicrotendipes		5	2
Diptera		3	1
Ephydridae			1
Eukiefferiella	64	10	13
Hemerodromia	3		1
Hydrobaenus		53	3
Micropsectra		1	10
Microtendipes	1		
Nilotanypus			1
Parametriocnemus	1		
Paratanytarsus			2
Paratendipes		49	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16058], Station #1, Sample Date: 3/16/2016 3:55:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Phaenopsectra		3	1
Polypedilum aviceps	3		
Polypedilum flavum	90	1	7
Polypedilum illinoense grp	1		19
Polypedilum scalaenum grp		9	
Rheotanytarsus	2		8
Simulium	10		
Stempellinella	3		1
Tanytarsus	5	8	5
Thienemanniella	1		3
Thienemannimyia grp.	16	3	10
Tribelos		1	
Tvetenia bavarica grp	5		1
EPHEMEROPTERA			
Acentrella	61		
Baetis	121		9
Caenis latipennis		7	
Diphetor	38		6
Fallceon	48		
Leptophlebia			3
Leucrocuta	10		
Maccaffertium modestum		1	3
Plauditus	1		
Stenacron		1	
Stenonema femoratum		5	2
ISOPODA			
Lirceus	20	17	56
LUMBRICINA			
Lumbricina		2	
NEOTAENIOGLOSSA			
Elimia			3
ODONATA			
Calopteryx			1
Stylogomphus albistylus		-99	
PLECOPTERA			
Leuctridae	1		
Perlesta	13		
TRICHOPTERA			
Cheumatopsyche	2		1
Chimarra	5		

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16058], Station #1, Sample Date: 3/16/2016 3:55:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Hydropsyche	-99		
Polycentropus		1	
TRICLADIDA			
Planariidae	38	7	23
TUBIFICIDA			
Limnodrilus hoffmeisteri		3	
Tubificidae	1	19	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16059], Station #3, Sample Date: 3/16/2016 5:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	3	9	1
AMPHIPODA			
Crangonyx	4	1	
Gammarus	5		
Hyalella azteca			40
Stygobromus	3	1	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Menetus			1
BRANCHIOBDELLIDA			
Branchiobdellida			2
COLEOPTERA			
Dubiraphia			3
Macronychus glabratus			2
Psephenus herricki	2		
Stenelmis	59	16	18
DECAPODA			
Faxonius macrus	1		
Faxonius neglectus	-99		1
Faxonius virilis			-99
DIPTERA			
Ablabesmyia		11	7
Chelifera	1		
Chironomidae	7	3	5
Corynoneura	1	11	2
Cricotopus bicinctus	2	1	2
Cricotopus/Orthocladius	42	36	87
Cryptochironomus	1	1	
Dicrotendipes	4	31	34
Diptera	1	2	
Ephydridae			1
Eukiefferiella	88	19	7
Hemerodromia	3	1	
Hydrobaenus	4	33	7
Labrundinia		1	2
Micropsectra	4	4	4
Nilotanypus		1	
Parametriocnemus	10	1	

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16059], Station #3, Sample Date: 3/16/2016 5:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Paratanytarsus	1		12
Paratendipes		22	1
Phaenopsectra		1	1
Polypedilum aviceps	3		
Polypedilum fallax grp	1		1
Polypedilum flavum	73	3	
Polypedilum illinoense grp	1		4
Polypedilum scalaenum grp	3	4	
Psychoda			1
Rheotanytarsus	2		1
Simulium	2		
Stempellina		1	
Stempellinella	8	5	5
Sympotthastia	2		
Tabanus	2		
Tanytarsus	42	8	25
Thienemanniella	2		1
Thienemannimyia grp.	22	6	18
Tvetenia bavarica grp	13	4	1
Zavrelimyia (Paramerina)			3
EPHEMEROPTERA			
Acentrella	3		
Acerpenna	2		
Baetis	13		2
Caenis latipennis	2	5	12
Diphetor	27		
Eurylophella enoensis			2
Leptophlebia	2	3	12
Leucrocuta	37		
Maccaffertium modestum	8	1	7
Siphlonurus			1
Stenacron	8	16	1
Stenonema femoratum	1	-99	3
ISOPODA			
Caecidotea (Blind & Unpigmented)	1	2	
Lirceus	53	8	8
LUMBRICULIDA			
Lumbriculidae		1	
NEOTAENIOGLOSSA			

Aquid Invertebrate Database Bench Sheet Report
Williams Cr [16059], Station #3, Sample Date: 3/16/2016 5:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Elimia			1
ODONATA			
Argia			1
Calopteryx			1
Enallagma			3
Stylogomphus albistylus			-99
PLECOPTERA			
Acroneuria	2		
Leuctridae	3		
Neoperla	3		
Perlesta	26		2
TRICHOPTERA			
Cheumatopsyche	10	1	6
Chimarra	12		
Polycentropus	1		
Pycnopsyche			-99
Triaenodes			1
TRICLADIDA			
Planariidae	7	1	1